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Final Report
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MATERIAL LABORATORY

NEW YORK NAVAL SHIPYARD

BROOKLYN 1, N. Y.

TECHNICAL REPORT

SECURITY INFORMATION

CRITICAL THERMAL ENERGIES OF PACKAGING MATERIALS

Submitted By The
BUREAU OF SUPPLIES AND ACCOUNTS, DEPARTMENT OF THE NAVY

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Lab. Project 5046-3, Part 25
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ABSTRACT

For the purpose of evaluating the resistance of materials to the thermal radiation of atomic explosions, the critical thermal energies of wood and fibre board packaging materials, submitted by the Bureau of Supplies and Accounts, were determined by exposing the materials to the Material Laboratory carbon-arc source of thermal radiation and examining the consequent damage. It was found that initial effects occur on woods in the range between 3.6 and 8.8 cal/cm^2 and on fibre boards between 5.1 and 6.2 cal/cm^2 when the radiation is applied at a rate of 85 cal/cm^2 sec. Temporary flaming occurred at radiant exposures between 6.5 and 13 cal/cm^2 for the woods and between 8 and 13 cal/cm^2 for the fibreboards; on the other hand, flame propagation was not observed for radiant exposures up to 107 cal/cm^2. Of the fibre boards evaluated, the laminated boards offer higher resistance to thermal radiation than the corrugated boards.

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Ref: (a) CGANYKNAVSHIPYD ltr C-S99/L5, Ser C-960-92, of 14 Mar 1950
(b) BUSHIPS restr spdltr, S99-(0)(348), Ser 348-7S, of 6 Apr 1950

Encl: (1) Critical Thermal Energies of Wood Materials Exposed to Thermal Radiation
(2) Critical Thermal Energies of Fibreboard Materials Exposed to Thermal Radiation

AUTHORITY

1. This investigation is part of the program proposed by reference (a) and formally authorized by reference (b). The general Thermal Radiation program is under the supervision of the Armed Forces Special Weapons Project.

INTRODUCTION

2. As part of its general program on the effects of the thermal radiation of atomic explosions on materials, the Material Laboratory is evaluating the characteristics under exposure to thermal radiation of the various materials under the cognizance of the several agencies of the Department of Defense. As data become available, these findings are published. In this report, the critical thermal energies of packaging materials submitted by the Bureau of Supplies and Accounts of the Navy Department are indicated. The materials evaluated included woods and fibreboards.

EQUIPMENT AND METHODS OF EXPOSURE

3. The critical thermal energies of the packaging materials were determined by exposing them to the Material Laboratory carbon-arc source of thermal radiation. The source consists of an 11-mm. carbon arc mounted at the focus of a mirror which collimates the emitted energy; a second mirror, which is mounted coaxially at a distance of 12 feet from the collimator, condenses the radiation to the mirror's focus. Gradations of thermal damage are

obtained by varying the effective exposure time through accelerating a 1x8-inch sample which moves transversely through the focus. The rate of application of energy was 85 cal/cm^2 sec over a central target area, 2 mm wide.

4. The degree and extent of thermal damage was determined by visual observation of the materials following exposure.

RESULTS

5. The critical thermal energies of the woods and fibreboards were defined as those which produce certain characteristic, reproducible effects on the materials such as scorching, charring, and destruction. The critical thermal energies are listed in enclosures (1) and (2).

6. It may be noted that the laboratory exposures have been produced under highly controlled conditions and, as a rule, give results which can be reproduced very well. However, for several reasons the data of enclosures (1) and (2) must be used with caution. The effects to be observed on material samples frequently remain unchanged over a considerable range of exposures. Since the surface effects are not sufficiently gradated for refined evaluations, only the initial stages have been recorded. The effects on material surfaces are influenced by such factors as mounting, geometry of material and of exposure, weathering, and the moisture content at the time of exposure. Differences in density, absorptivity, chemical composition and particle size are responsible for variations in effects which may be observed from area to area on the same material. Liquids and gases form during exposure to thermal radiation, even in a period of less than one second, thereby affecting the amount of thermal radiation incident on and absorbed by the surface.

7. Although flaming was observed during the exposures, a propagating flame was not noted, even at the maximum radiant exposure of 107 cal/cm^2.

SUMMARY

8. The results of this investigation may be summarized as follows:

a. Upon exposure to the carbon-arc source of thermal radiation, the fibre-boards suffer initial effects of scorching at radiant exposures ranging from 5.1 to 6.2 cal/cm^2, and the woods at radiant exposures ranging from 3.6 to 8.8 cal/cm^2.

b. Under the same conditions, the fibre-boards flame at radiant exposures ranging from 6.8 to 13 cal/cm^2 and the woods at values ranging from 6.5 to 13 cal/cm^2, depending upon the type submitted. On the other hand, none of the materials indicated a propagating flame or continued to burn after the exposure.

c. None of the materials were destroyed completely, but the outer layers of the fibreboards were destroyed at radiant exposures ranging from 20 to 79 cal/cm^2, depending upon the specific boards evaluated.

d. The difference in resistance to thermal radiation between the laminated and the corrugated fibreboards is marked; the outer layers of the two laminated boards were destroyed at 20 and 24 cal/cm^2, while those of the two corrugated boards were destroyed at 35 and 49 cal/cm^2.

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Approved:

H. T. Koonce

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The Director

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Critical Thermal Energies of Wood Materials
Submitted By The Bureau of Supplies and Accounts

No.	Material	Description of Effects	C.E. (cal/cm^2)
1	Wood, Ash	First grain chars Flames during exposure Second grain chars	5.6 11-13 20
2	Wood, Bass	Charring Flames during exposure	5.9 9.1
	Wood, Cedar	Charring Flames during exposure	4.7 6.5
3	Wood, Fir	First grain chars Second grain chars Flames during exposures	4.6 10 11-13
4	Plywood, Fir	First grain chars Second grain chars, flames during exposure	3.6 11-13
5	Wood, Oak	First grain chars Second grain chars, flames during exposure	4.1 11-13
	Wood, Redwood	First grain chars Second grain chars, flames during exposure	4.0 6.8
6	Wood, Spruce	First grain chars Second grain chars, flames during exposure	6.1 9.3
7	Wood, Sugar Pine	First grain chars Second grain chars, flames during exposure	5.6 11-13
8	Wood, Yellow Pine	First grain chars Flames during exposure Second grain chars	6.0 11-13 19

Critical Thermal Energies of Fiber Boards

Submitted By The Bureau of Supplies and Accounts

No.	Material	Description of Effect	C.E. (cal/cm^2)
1	Fiber Board, V2S, JAN-P-108, B.T. 350 PSI,	Scorching Flames during exposure Outer layer destroyed, Bonding material exposed and melted	6.2 11-13 20
2	Fiber Board, V3S, JAN-P-108, B.T. 275 PSI,	Scorching Flames during exposure Outer layer destroyed Bonding material exposed and melted	5.1 8.8 24 24
3	Fiber Board, V3C JAN-P-108 B.T. 350 PSI	Scorching Flames during exposure Outer layer destroyed Corrugated inner layer destroyed	5.8 7.5 49 79
4	Fiber Board, W3C, JAN-P-108, B.T. 200 PSI	Scorching Flames during exposure Outer layer destroyed Corrugated inner layer destroyed	5.5 6.8 35 59